If the experimental values of $(2H_\alpha)$ are plotted against the corresponding values of log a_w, the points fall nearly on a straight line with the fit of the line well within experimental error. Least-squares analysis yields for the line

$$(2H_\alpha) = 35.3_7 - 8.17_8 \log a_w \quad (3)$$

The general equation for a straight line with coordinates $(2H_\alpha)$ and log a_w is

$$(2H_\alpha) = (2H_\alpha)^0 + S \log a_w \quad (4)$$

where $(2H_\alpha)^0$ is the value of $(2H_\alpha)$ at log $a_w = 0$, and S is the slope of the line. For any system, by definition

$$\mu_w - \mu_w^0 = 2.303 \, RT \log a_w \quad (5)$$

Combining Eqs. 4 and 5, we obtain Eq. 1; by substituting the values of $(2H_\alpha)^0$ and S from Eq. 3 into Eq. 1, we obtain Eq. 2.

The apparent optic axial angle $(2H_\alpha)$ depends on both $(2V_\alpha)$, the true optic axial angle of the crystal, and the refractive index of the medium in which the crystal is immersed. Thus, it is surprising that $(2H_\alpha)$, a property of the total system, should be related in such a simple manner to the chemical potential of water. Furthermore, for a system at equilibrium μ_w is everywhere the same, so that $(2H_\alpha)$ also is a measure of μ_w in the crystal.

We have also investigated a stellerite containing a small percentage of sodium ions. For this crystal the same straight-line relationship between $(2H_\alpha)$ and log a_w holds, although values of the equation constants are different.

It seems likely that Eq. 1 can be used to measure a_w in aqueous solutions either to establish thermodynamic properties or to monitor systems. Similar relationships may exist between the optic axial angle and the activity of a component in solid solutions for other systems.

G. DONALD EBERLEIN
C. L. CHRIST

*U.S. Geological Survey,
Menlo Park, California 94025*

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2-Amino-5-(1-methyl-5-nitro-2-imidazolyl)-1,3,4-thiadiazole: A New Antimicrobial Agent

Abstract. *The title compound has been prepared and shown to be highly active against a wide variety of gram-positive and gram-negative bacteria in mice and chicks, as well as against a number of parasitic infections in rodents.*

We have prepared a compound which we believe to be one of the most active synthetic, broad spectrum, anti-bacterial-antiparasitic agents known: 2-amino-5-(1-methyl-5-nitro-2-imidazolyl)-1,3,4-thiadiazole (I).

I
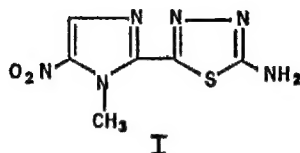
As a consequence of a program of synthesis (*1*) of novel nitroheterocyclic aldehydes and their elaboration into structures suggested by the antibacterial nitrofurans, structure I was prepared in 81 percent yield by the ferric ammonium sulfate oxidative cyclization of 1-methyl-5-nitroimidazole-2-carboxaldehyde thiosemicarbazone (*2*) in hot water. Recrystallized from dimethylformamide, the sample had a melting point of 270°–271°C; microanalysis for C, H, N, and S was satisfactory; and the nuclear magnetic resonance spectrum (dimethylsulfoxide-d_6) showed bands at τ 1.73 (singlet, ring H), τ 2.13 (broad singlet, NH_2), and τ 5.59 (singlet, CH_3).

In the chick, compound I was approximately equivalent to furazolidone orally against both *Salmonella gallinarum* and *Escherichia coli* and was highly effective against *Pasteurella multocida*. In the mouse, it was at least as effective as furazolidone orally against *Salmonella choleraesuis* and highly efficacious versus *Pasteurella multocida*. The median effective oral dose was less than 1 mg/kg against *Neisseria meningitidis* and between 10 and 90 mg/kg for *Klebsiella pneumoniae*, *Salmonella typhosa*, *Escherichia coli*, *Aerobacter aerogenes*, and *Shigella flexneri* infections in the mouse. It was highly effective against *Streptococcus pyogenes* and a number of strains of *Staphylococcus aureus*. In rodents, the agent was active against the following parasitic infections: *Trichomonas vaginalis*, *Entamoeba histolytica*, *Trypanosoma equiperdum*, *Trypanosoma cruzi*, and *Leishmania donovani*. Compound I was also active against *Eimeria tenella* in the chick at 125 parts per million in the diet.

Test results on a large number of analogs of compound I indicate that several types of structural changes can be made, including the substitution of an aminooxadiazole for the aminothiadiazole ring, with the retention of a substantial degree of biological activity.

GERALD BERKELHAMMER
GORO ASATO

*Agricultural Division,
American Cyanamid Company,
Box 400, Princeton, New Jersey 08540*

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27 September 1968

Size-Detecting Mechanisms in Human Vision

Abstract. *Inspecting a pattern of alternating dark and light bars makes it difficult to see a similar pattern presented afterward. This phenomenon can be used to isolate mechanisms responsive to bars of a given width. Our results suggest that the human visual system contains several different classes of size detectors, each maximally sensitive to visual targets with sizes in a particular range.*

The ability to appreciate the size of an object is a basic visual perceptual function, and much research has been concerned with the indirect or higher-order processes contributing to this ability (*1*). We tried to determine whether, in addition to use of these indirect cues, the human visual system can directly encode the area of retinal images produced by objects of different sizes.

The observation of a pattern of alternating dark and light bars reduces the visibility of a similar pattern presented thereafter (*2*). This phenomenon may be exploited to isolate mechanisms responding to patterns whose bars are of a particular size. One measure of the size of a bar in a pattern of alternating light and dark bars is the number of such alternating pairs (or cycles) occupying a given area. This quantity is termed spatial frequency, with values expressed in number of cycles per degree (cycle/deg) of visual angle. In

our experiment the threshold for gratings with different spatial frequencies was measured after adaptation to gratings of various spatial frequencies. It is assumed that the ability of an adaptation pattern with a given spatial frequency to affect the visibility of a test grating with the same or some other spatial frequency reflects the extent to which the perception of both gratings depends on common mechanisms. A description of the spatial-frequency responsivity (or tuning) of the mechanism mediating the perception of a test grating of a given spatial frequency can be obtained by an analysis of the interactions between that test grating and adaptation gratings with various spatial frequencies.

Eleven different adaptation patterns were used in our experiment. Ten were photographic square-wave gratings with horizontal bars whose spatial frequencies, at the observer's eye, were 0.18, 0.35, 0.70, 1.05, 1.40, 2.10, 2.80, 3.50, 10.12, and 22.00 cycle/deg. The luminance of a light bar of any grating was 1.35 ft lam (1 ft lam = .92 mlam); that of each dark bar was 0.45 ft lam. The 11th adaptation pattern was a uniform field whose luminance was equivalent to that of the mean luminance of the grating patterns, 0.90 ft lam. All fields were presented in Maxwellian view to the observer's right eye by a four-channel optical system (3). Each circular adaptation field subtended a visual angle of 9° and had a small, dark, central fixation point.

For the first 4 minutes of every experimental session the observer inspected one of the 11 adaptation patterns. The same pattern remained visible to the observer for the entire session except for brief periods when test grating targets were presented. To minimize the development of negative afterimages of the grating bars, the adapting pattern was mechanically shifted every 3 seconds by one-half cycle, interchanging the dark and light bars. Within each session two independent determinations were made of the luminance threshold for each of three different test gratings, 0.35, 1.05, and 3.50 cycle/deg. These test gratings were oriented horizontally and appeared in the same part of the visual field as the adaptation patterns.

The following was the sequence of events on each trial. The adaptation pattern was extinguished for 0.7 second (interval 1); it reappeared for the following 1.5 seconds and was extinguished again for another period (interval 2) of 0.7 second. The adaptation
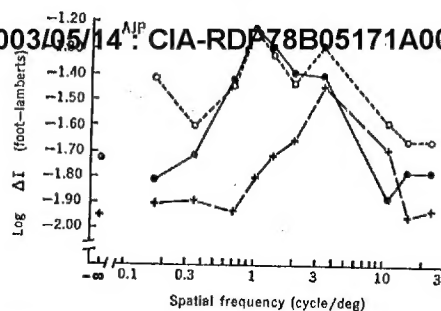
Fig. 1. Luminance threshold for test gratings of various spatial frequencies as a function of the spatial frequency of the adaptation grating. Data obtained with a test grating of 0.35 cycle/deg are indicated by unfilled circles; 1.05 cycle/deg, filled circles; and 3.50 cycle/deg, crosses. Data from observer A.P.

pattern was presented again, remaining on for the next 9.1 seconds. The entire sequence was begun again for the next trial. The test grating was presented, superposed on a homogeneous background of 0.58 ft lam, either in interval 1 or in interval 2. It occurred with equal frequency in the two intervals according to a random schedule. The interval without the test grating contained only the homogeneous background. The observer had to identify the interval containing the test grating. If this identification was wrong, the luminance of the light bars of the test grating was increased by 0.1 log unit for the presentation on the next trial. If identification was correct on three successive trials, the luminance was reduced by 0.1 log unit for the next trial. These rules for adjusting luminance to match the observer's performance generate a series of data points which bracket the stimulus value corresponding to the 79.4-percent point on the traditional "frequency of seeing" curve
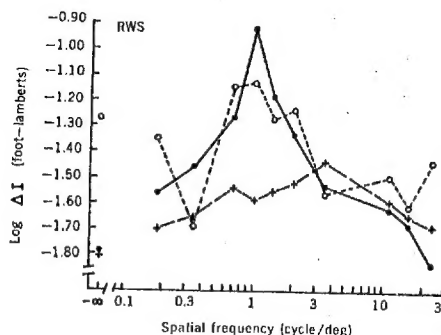

Fig. 2. Luminance thresholds for test gratings of various spatial frequencies as a function of the spatial frequency of the adaptation grating. Data obtained with a test grating of 0.35 cycle/deg are indicated by unfilled circles; 1.05 cycle/deg, filled circles; and 3.50 cycle/deg, crosses. Data from observer R.S.

(4). Each series was begun with a randomly chosen luminance for the test bars, and continued until the occurrence of five reversals in the direction of change in luminance (either decreasing to increasing, or vice versa). The threshold in a series was defined as the mean luminance of the light bars of the test grating for the last four of the five reversals in that series. Each of the two observers was tested in 22 sessions, giving four independent determinations of threshold for each of the 33 combinations of adaptation and test patterns.

Figures 1 and 2 show the mean threshold luminance of the light bars of the test target as a function of the spatial frequency of the adaptation grating. Any individual function describes the change in the threshold for a test grating of a particular spatial frequency as the spatial frequency of the adaptation grating was varied. To make statistical comparisons between the shapes of the functions, we made three separate analyses of variance. In each analysis the data obtained with a different pair of test targets were compared, and data for both observers were entered in each analysis. The analysis of variance term of interest represents the interaction between the spatial frequencies of the adaptation and test patterns. This term reflects the statistical significance of the difference between the shapes of any two test target functions.

The shape of the threshold function for the test grating of 3.5 cycle/deg differed from that obtained with test grating of 0.35 cycle/deg ($F = 3.19$, d.f. $= 10,10$; $P < .05$); it also differed from that obtained with the test grating of 1.05 cycle/deg ($F = 8.26$, d.f. $= 10,10$; $P < .01$). One obvious difference among these threshold functions is the location of their peaks. Whereas the peaks of the threshold functions for the test gratings of 0.35 and 1.05 cycle/deg occurred with the adaptation grating of 1.05 cycle/deg, the peak of the threshold function for the test grating of 3.5 cycle/deg occurred at a higher spatial frequency of the adaptation grating. This implies that the spatial-frequency tuning of the respective mechanisms is different.

In contrast to the above, the functions for the test gratings of 0.35 and 1.05 cycle/deg have nearly identical shapes ($F = 1.31$, d.f. $= 10,10$; $P > .25$), suggesting that the spatial-frequency tuning of the mechanisms mediating the detection of the gratings is similar. This latter finding suggests

that the number of differentially t ... ly involved in the perception of slowly ... ... nating in the lateral genicu-classes of spatial-frequency mechanisms moving targets. late nucleus. Since it occurs in total is limited.

Spatial filters of the kind measured in darkness as well as in light, it would

These conclusions are similar to those our experiment may also contribute seem to be caused by the same neural reached by Campbell and Robson (5) to the phenomenon of size constancy. apparatus causing the eye movements. from a Fourier analysis of the visibility When an object moves toward or This presynaptic inhibition could pro-of gratings of different spatial frequen-away from an observer, the size of the vide a mechanism for a blanking of cies and waveforms. The spatial filters, retinal image of that object varies. The visual information during an eye move-identified by our method and by that of fact that phenomenal size, under a va-ment. Campbell and Robson, could derive riety of conditions, remains relatively

My purpose was to determine whether from cells in the visual system as de-unchanged is the central fact of size any blanking out occurs by the time scribed by Enroth-Cugell and Robson constancy. Richards' (7) model of size visual afferent information reaches cere-(6); each of these cells, because of the constancy postulates shifts, during ac-bral cortical neurons. With the eye organization and size of its receptive commodation and convergence, among stationary, responses of single neurons field, tends to be maximally responsive sets of spatial filters which, like those in the visual cortex were studied in to a grating of a particular spatial fre-we have described, are tuned to differ-awake, unanesthetized monkeys and quency. ent retinal image areas. the size, shape, orientation, and location

In addition to their possible involve-of the stationary or slowly moving ment in the perception of spatial ex-visual stimulus necessary to activate the tent, spatial filters may function dif-neuron (the receptive field characteris-ferentially in the perception of targets tics) were determined. Then, the effect moving at different speeds. Pantle (3) of this stimulus on the cell was tested measured the luminance threshold for during an eye movement. a moving test grating of constant spatial

First, rhesus monkeys were presented frequency presented after the observer with a tangent screen 58 cm in front of had viewed a stationary-adaptation them. Each time the monkey pressed a grating having one of a number of dif-bar, a slit of light 0.5 degree of arc ferent spatial frequencies. Although long (the fixation light) appeared at the adaptation gratings with low-spatial center of the tangent screen and re-frequencies raised the threshold for mained on for 1 to 3 seconds. After this fast-moving test gratings, adaptation variable interval, the fixation light gratings with high-spatial frequencies dimmed for 400 msec; if during that were needed to raise the threshold for time the monkey released the bar, it was slowly moving test gratings. This rela-rewarded with a drop of fruit juice or tion between the spatial frequency of water. That the monkey was actually the adaptation grating and the speed fixating during the experiment was de-of the test grating suggests that spatial termined by measuring the eye move-filters sensitive to large areas (low-ments with an electrooculogram de-spatial frequencies) are particularly in-rived from the electrodes pasted on the volved in the perception of quickly mov-skin. ing targets; filters sensitive to small areas

Next, responses of spontaneously (high-spatial frequencies) are particular-active single cells were recorded from the striate area of visual cortex by means of a movable microelectrode positioner and glass-insulated platinum microelec-

ALLAN PANTLE*
ROBERT SEKULER
*Department of Psychology,
Northwestern University,
Evanston, Illinois 60201*

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* Present address: Department of Psychology, University of California, Los Angeles.

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Visual Cortex Neurons: Response to Stimuli during Rapid Eye Movements

Abstract. *While awake, unanesthetized monkeys held their eyes stationary, a motionless or slowly moving stimulus falling on the receptive field of striate cortex neurons produced an excitatory response. When a rapid eye movement was made across the same stimulus, many of these neurons continued to give an excitatory response. But the discharge of other neurons was unchanged or was suppressed during the eye movement.*

With each movement of the eye, the visual world sweeps across the retina. The maximum rate of such movement during the rapid (saccadic) eye movements is about 700 degrees of arc per second for man, 900 degrees per second for monkeys (1). A stimulus moving in front of the stationary eye at this speed appears only as a blur. Yet during these eye movements there is an apparent blanking out of vision.

During the phase of sleep character-ized by rapid eye movements (2), there is a decrease in the visual evoked re-sponse in the lateral geniculate nucleus of cats with each rapid eye movement. This effect apparently results from a presynaptic inhibition of the optic tract

trodes (3). During recording, the mon-key sat in a primate chair with its head held rigid (4). When single-cell activity was recorded, a search was made for its receptive field by projecting a second light (in addition to the fixation light) onto the screen. The receptive field stimulus was a white light with an inten-sity of 1.0 to 1.5 log units above that of the background illumination (1 cd/m²). Each time the monkey began the fixa-tion period of several seconds, a search for the receptive field was made by mov-ing the stimulus in the visual field and by changing its size and shape.

Finally, when the receptive field of a cell had been at least approximately de-termined, a horizontal, saccadic eye movement through 20 degrees of arc was elicited. The fixation light was